



Northeastern

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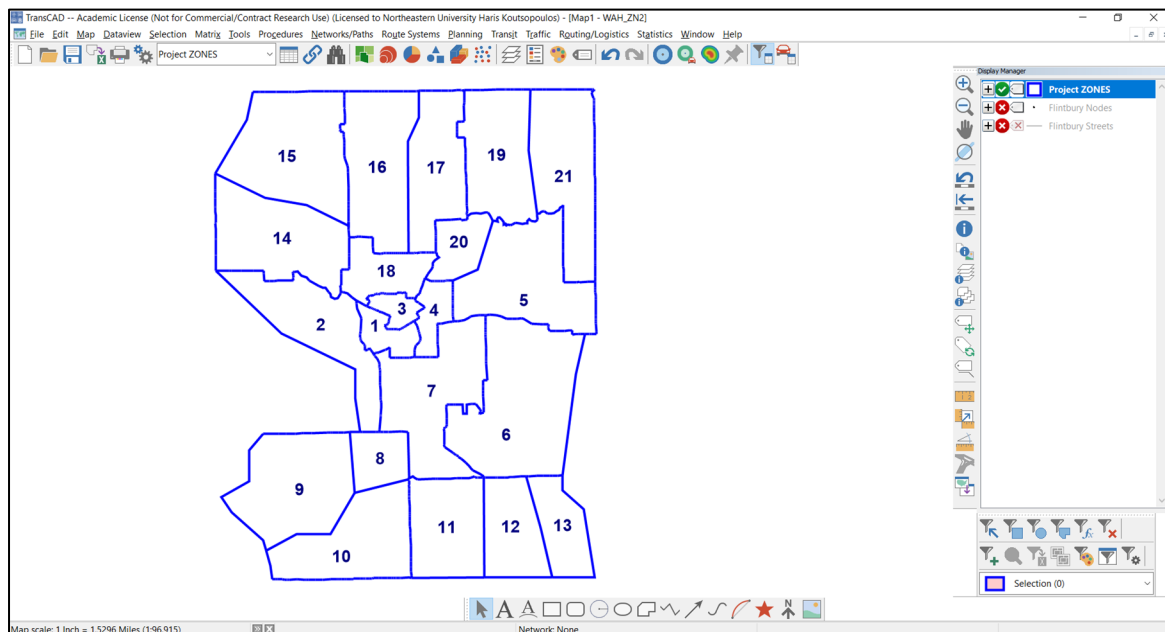
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**CIVE 7381 Transportation Demand
Mini Project Parts AB (Problem Set #5)
Due: Monday November 10, 2024**

INSTRUCTIONS. For this assignment you can work in teams of at most 2 people. Each team will prepare one report, but each member of the team should submit a copy of the (same) report individually (for CANVAS bookkeeping purposes). Your report should be submitted in **pdf** format (supporting files can be in the native format, e.g. xlsx). **Make sure you include the names of the members of the team on the first page.** You can use Excel, or any software of your choice (e.g. python, R, matlab).

A town, illustrated in the figure below, has been divided into 21 zones (TAZ). The planning authority in the city is developing a travel demand forecasting model for the area. All the data that are needed for this mini project are in the files *project-data-part-AB.xlsx* and *project-data-part-C.xlsx* (the part C data will be used in a later assignment). These data files can be found on Canvas under the Assignments module, *Problem Set 5 (Mini project parts A and B)*, in the page *Mini Project Data*.



Part A: Trip Generation

The planning authority has developed a cross-classification model for home-based other (HBO) trip productions and attractions.

The **trip production** rates for HBO trips, in trips per household per day, are given below:

		Household Size		
		1	2	3+
auto ownership (# veh)	0	1.9	3.0	3.5
	1	1.8	3.5	4.8
	2+	1.6	3.4	5.3

The **trip attraction** rates for HBO trips, in trips per day, are given in the table below:

	Attractions per household	Attractions per retail employee	Attractions per non-retail employee
HBO	0.4	1.8	2.3

In addition to the trips generated according to the above attraction model, some of the zones have special attractors that generate additional trips. Hence, once the attractions have been calculated, based on the demographic/socioeconomic characteristics of the zones in the study area, the attractions of special generators must be calculated and added to the zone total. The special generators and the corresponding trip rates (per day) they attract are:

Zone	Generator	Size	Unit	Attracted trips per unit
6	Hospital	340	beds+employees	1.8
8	Port	395	employees	0.3
20	University	2,850	students	1.4
21	Shopping Center	46,500	ft ²	0.024

The demographic/socioeconomic data for the 21 zones are summarized in the table that follows (included in the file *project-data-part-AB.xlsx*).

	Households (HH) per group									total	retail	non-retail	
Family Size	1			2			3+						
Auto ownership:	0	1	2+	0	1	2+	0	1	2+	HH	employees	employees	
Zone	1	120	180	20	100	335	60	5	95	125	1,040	1,005	5,050
	2	100	75	5	65	75	100	15	100	130	665	665	1,500
	3	130	155	105	35	140	200	15	185	235	1,200	750	1,850
	4	85	210	25	75	150	240	55	100	390	1,330	180	2,465
	5	20	135	10	15	80	110	100	90	125	685	205	955
	6	80	310	40	70	190	320	20	100	480	1,610	350	1,100
	7	20	40	5	15	30	65	15	75	110	375	480	1,260
	8	5	5	10	10	15	5	10	5	5	70	75	410
	9	20	210	15	20	50	155	10	70	250	800	105	350
	10	75	95	5	25	60	115	5	90	375	845	130	400
	11	70	135	15	35	70	170	10	40	215	760	75	220
	12	50	260	35	40	170	420	25	75	330	1,405	440	850
	13	30	290	20	40	250	325	10	60	210	1,235	160	230
	14	95	165	45	25	135	260	100	120	330	1,275	250	300
	15	30	110	15	10	75	170	20	120	205	755	170	285
	16	20	90	20	5	25	95	15	80	255	605	100	135
	17	50	105	5	5	35	130	35	70	295	730	245	300
	18	40	190	10	60	135	85	10	65	125	720	450	950
	19	35	85	30	30	55	120	10	90	180	635	265	450
	20	400	250	5	350	225	100	105	100	175	1,710	425	205
	21	45	110	10	15	110	140	10	30	140	610	300	855

1. Calculate the total HBO trips produced by each zone. Using the demographic/socioeconomic data and the cross-classification model provided above calculate the productions for each zone.
2. Calculate the attractions for each zone. Using the attraction model and the special generators and other information above calculate the total attractions per zone.
3. Balance total productions and attractions. Once the total productions and attractions have been calculated, they must be balanced. Note that external trips are not included in the analysis. You may assume that they are 0.

This part of your report should include a table with columns of the calculated productions and attractions, as well as the corrected values for each zone. Mention all your assumptions and show the calculation of the adjustment factor.

Part B. Trip Distribution

In this part the productions and attractions that you calculated in the trip generation part are converted into zone-to-zone trips, using the gravity model.

$$T_{ij} = P_i \cdot \frac{A_j F_{ij}}{\sum_{j=1}^J A_j F_{ij}}$$

where, T_{ij} = the number of trips from zone "i" to zone "j"

P_i = the number of productions from zone "i"

A_j = the number of attractions to zone "j"

F_{ij} = the friction factor between zone "i" and zone "j"

The zone-to-zone travel times are given in the table below. Travel times include the terminal times within the production and attraction zone as well. The information is also available in the file: *project-data-part-AB.xlsx*.

The friction factor between zones i and j, F_{ij} , is a function of the travel time between the two zones i and j. The friction factors for different travel times and trip purposes are shown in the second table below. The table is also included in the file: *project-data-part-AB.xlsx*.

Zone-to-Zone Travel Times (minutes). Values include terminal times

To From	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1		10	12	15	24	11	10	13	19	22	21	17	25	16	20	21	27	23	29	25	31
2	14		10	13	17	22	19	23	26	29	27	28	32	8	12	11	16	12	17	15	20
3	16	13		8	14	15	15	18	24	26	27	25	28	12	15	11	15	11	15	14	19
4	19	16	11		10	10	14	17	25	27	28	23	25	15	18	14	15	13	12	10	14
5	28	20	17	12		10	12	16	21	22	19	14	13	15	19	16	15	14	15	11	12
6	15	25	18	13	12		12	15	19	20	18	13	14	17	19	18	18	16	17	15	17
7	14	22	18	16	13	13		8	13	12	10	11	17	16	18	16	17	14	18	16	20
8	17	26	21	19	17	17	10		10	10	11	14	18	18	20	19	19	16	20	19	22
9	23	29	27	27	22	21	14	12		12	13	16	18	22	25	26	27	25	28	27	33
10	26	32	29	29	23	22	13	11	12		10	13	15	21	23	24	25	24	27	26	32
11	25	30	30	30	22	20	11	12	13	10		10	14	20	22	23	24	23	26	24	30
12	21	31	28	25	15	15	12	15	16	13	10		12	18	20	21	22	21	24	22	28
13	29	35	31	27	14	16	18	19	18	15	14	12		22	25	26	27	26	28	26	33
14	20	12	15	17	16	19	17	19	22	21	20	18	22		13	16	18	17	21	20	24
15	24	15	18	20	20	21	19	21	25	23	22	20	25	13		12	15	18	21	19	23
16	25	14	14	16	17	20	17	20	26	24	23	21	26	16	12		10	12	14	15	17
17	31	19	18	17	16	20	18	20	27	25	24	22	27	18	15	10		10	12	13	15
18	27	15	14	15	15	18	15	17	25	24	23	21	26	17	18	12	10		14	12	15
19	33	20	18	14	16	19	19	21	28	27	26	24	28	21	21	14	12	14		12	14
20	29	18	17	10	12	17	17	20	27	26	24	22	26	20	19	15	13	12	12		14
21	35	23	22	16	12	19	21	23	33	32	30	28	33	24	23	17	15	15	14	14	

Friction Factors for Different Travel Times (minutes)

Travel Time	HBW Factor	HBO Factor	NHB Factor
1	30	70.00	33
2	20	40.00	20
3	15	22.00	15
4	10	15.00	10
5	8	9.60	7.5
6	5.6	8.00	6
7	4.5	5.20	4.5
8	3.5	3.80	3.4
9	2.8	2.70	2.8
10	2.2	2.00	2.2
11	1.8	1.80	1.8
12	1.5	1.40	1.5
13	1.3	1.00	1.2
14	1.1	0.85	1
15	0.9	0.80	0.8
16	0.74	0.60	0.7
17	0.62	0.52	0.5
18	0.55	0.45	0.5
19	0.5	0.40	0.42
20	0.44	0.34	0.36
21	0.38	0.30	0.31
22	0.35	0.26	0.24
23	0.32	0.24	0.25
24	0.29	0.21	0.22
25	0.28	0.18	0.19
26	0.25	0.16	0.16
27	0.24	0.15	0.16
28	0.23	0.13	0.14
29	0.22	0.13	0.13
30	0.2	0.12	0.13
31	0.19	0.10	0.1
32	0.18	0.09	0.1
33	0.17	0.08	0.09
34	0.17	0.07	0.09
35	0.16	0.07	0.08

Use (a) the zone-to-zone travel times, (b) the corresponding friction factors, and (c) the productions and attractions calculated in part A, to complete the trip distribution.

Perform the following:

1. Complete the travel time matrix by adding intra-zonal travel times. To find these travel times, use the "nearest neighbor" technique (*half the travel time from the zone of interest to its nearest neighbor*).

2. Create the matrix of the inter-zonal friction factors, based on the travel times and friction factors provided.
3. Create a matrix of the zone-to-zone trip distribution using the gravity model. The inputs will be the balanced productions and attractions you calculated in part A and the matrices you developed in question 2) above.
4. Check if the trips calculated in question 3) satisfy the total attraction and production constraints. If not, use any of the methods discussed in class to balance productions and attractions for each zone.

Your report for part B should include the completed travel time matrix (with intra-zonal travel times), the matrix of friction factors, and the matrix of the zone-to-zone origins and destinations (including intermediate iterations).